BIOLOGICAL EVALUATION OF GYPSY MOTH

at

Catoctin Mountain Park

2000

Prepared by

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ABSTRACT

In the Fall of 2000, USDI Park Service personnel and USDA Forest Service personnel conducted gypsy moth egg mass surveys at Catoctin Mountain Park (CMP) to assess the potential for defoliation and the need for treatment in 2001. Current populations are sufficient to cause noticeable defoliation on approximately 839 acres. Treatment is recommended in 2001 to prevent defoliation and possible tree mortality.

METHODS

A preliminary egg mass survey was conducted throughout CMP at established grid points and where gypsy moth egg masses were observed. At each sample point, a $1/40^{th}$ acre fixed radius plot was established. The plots consisted of a tally of all new (2000) egg masses observed on overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. The survey revealed high concentrations of gypsy moth in the northwestern corner and in the eastern portion of CMP. Other areas of the park had extremely low gypsy moth population levels.

USDA Forest Service personnel conducted a follow-up survey in the areas recognized to contain high gypsy moth populations, noticeably in the northwestern corner and the eastern portion of CMP. Similar to the preliminary survey, $1/40^{th}$ fixed radius plots were used at each sample plot.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The location of the survey plots are shown in Figure 1 and the survey results are summarized in Table 1. Egg mass densities ranged from 0-5,280 and averaged 613 egg masses per acre. Egg mass lengths tended to be moderate to large in size, ranged from 15-45 mm and averaged 29 mm.

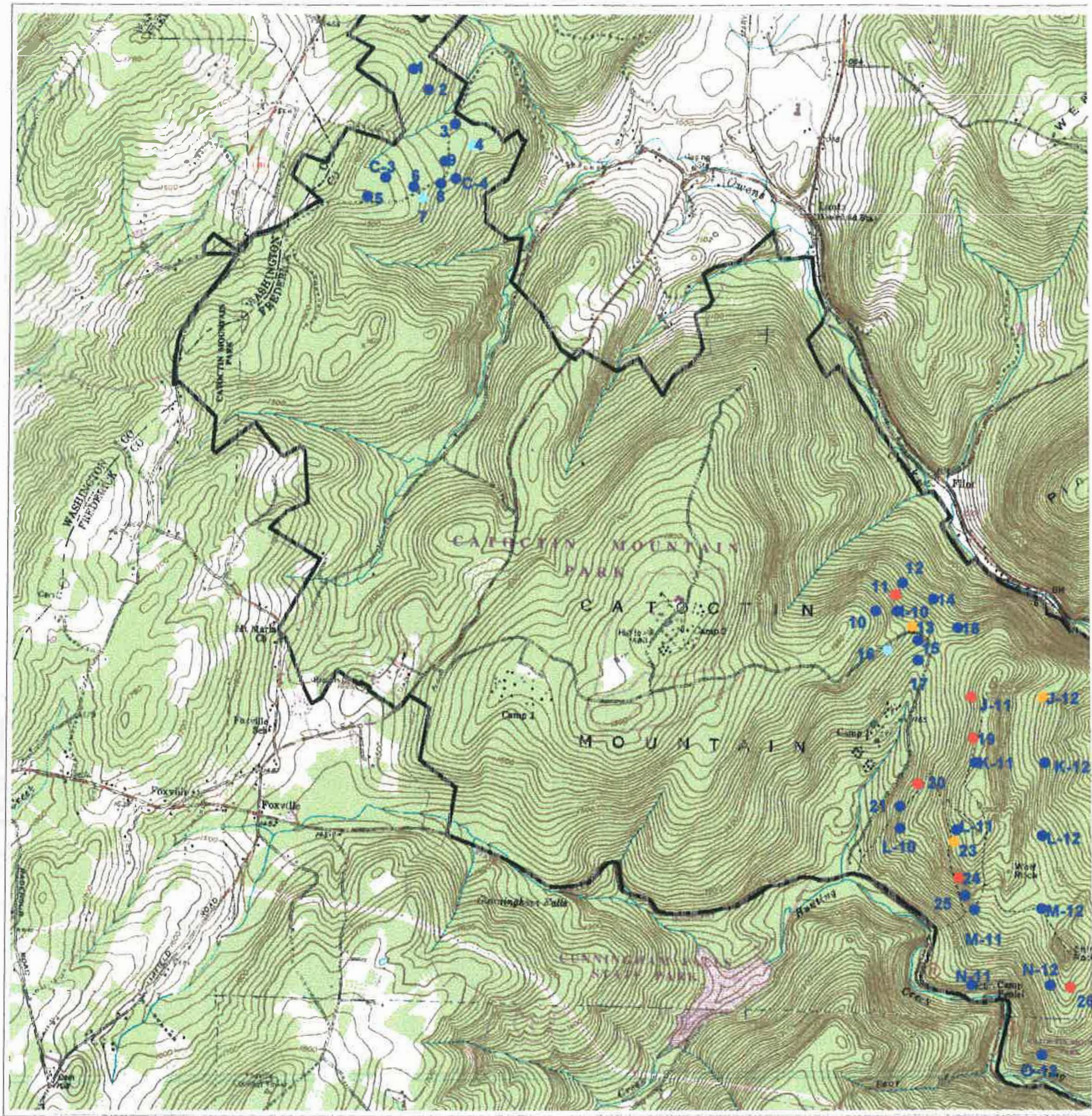
DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The survey results indicate that moderate defoliation is likely to occur on approximately 839 acres in the eastern portion of CMP in 2001 (Figure 2).

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would increase

Figure 1.-- Gypsy moth egg mass survey plots at Catoctin and November 28-29, 2000.



Mountain Park, October 25

Egg Mass Survey Points

- 0 - 249 egg mass/acre
- 250 - 749 egg mass/acre
- 750 - 1999 egg mass/acre
- 2000 + egg mass/acre
- Boundary

N
W E
S

0.6 0 0.6 1.2 Miles

USDA Forest Service 1/01 Steketee

Table 1. – Gypsy moth egg mass survey results at Catoctin Mountain Park, October 25 and November 28-29, 2000.

Plot	Number EM/Acre	Plot	Number EM/Acre
C-3	0	3	0
C-4	240	4	360
I-10*	200	5	0
J-11*	5,280	6	0
J-12*	980	7	600
K-11*	160	8	0
K-12*	0	9	120
K-13*	0	10*	0
K-14*	240	11*	2,440
L-10	0	12*	120
L-11*	40	13*	1,720
L-12*	120	14*	160
L-13*	120	15*	80
L-14*	1,480	16*	360
M-11*	0	17*	120
M-12*	0	18*	40
M-13*	960	19*	2,720
M-14	40	20*	2,800
N-11	0	21*	160
N-12*	120	22*	2,120
N-13*	120	23*	1,120
O-12	0	24*	2,120
O-13	80	25*	40
1	0	26*	2,640
2	0		

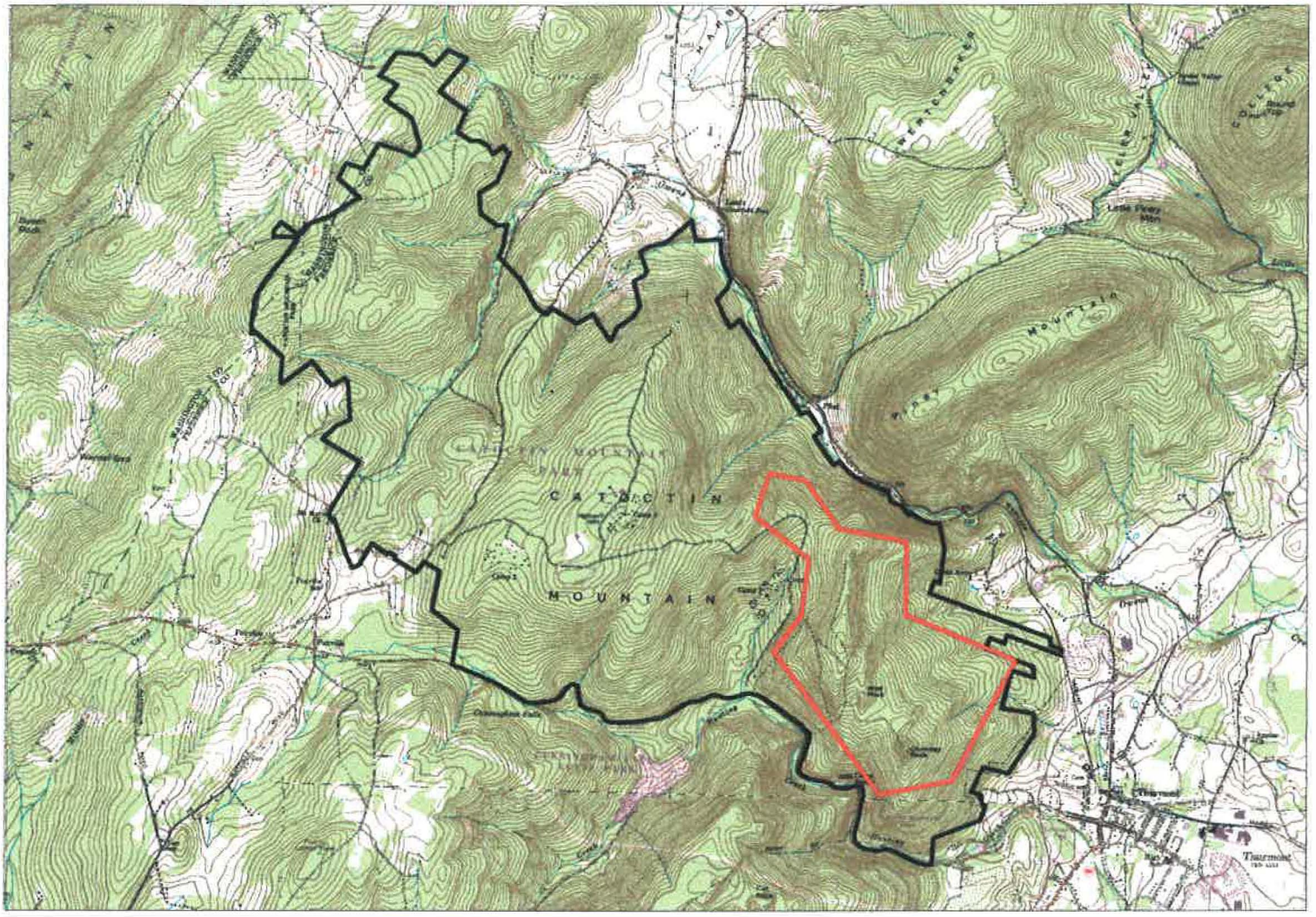
Egg mass/acre range = 0-5,280
Egg mass/acre average = 613

Egg mass size range (mm) = 15-45
Egg mass size average (mm) = 29

Egg mass/acre range in proposed treatment block = 0-5,280
Egg mass/acre average in proposed treatment block = 914

* = denotes plot is located in proposed treatment block

Figure 2.--- Area where gypsy moth defoliation is likely in 2001/
Proposed treatment block for 2001.



Proposed Treatment Block

839 acres

CMP Boundary

N
W
E
S

0.7 0 0.7 1.4 Miles

USDA Forest Service 1/01 Steketee

the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 914 egg masses per acre (average egg mass density in the eastern portion of CMP) x 29 mm (average egg mass length) translates to a projected defoliation level of about 39 percent (moderate defoliation). Because egg mass densities and host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately moderate throughout this area of CMP. No defoliation is expected elsewhere at CMP in 2001.

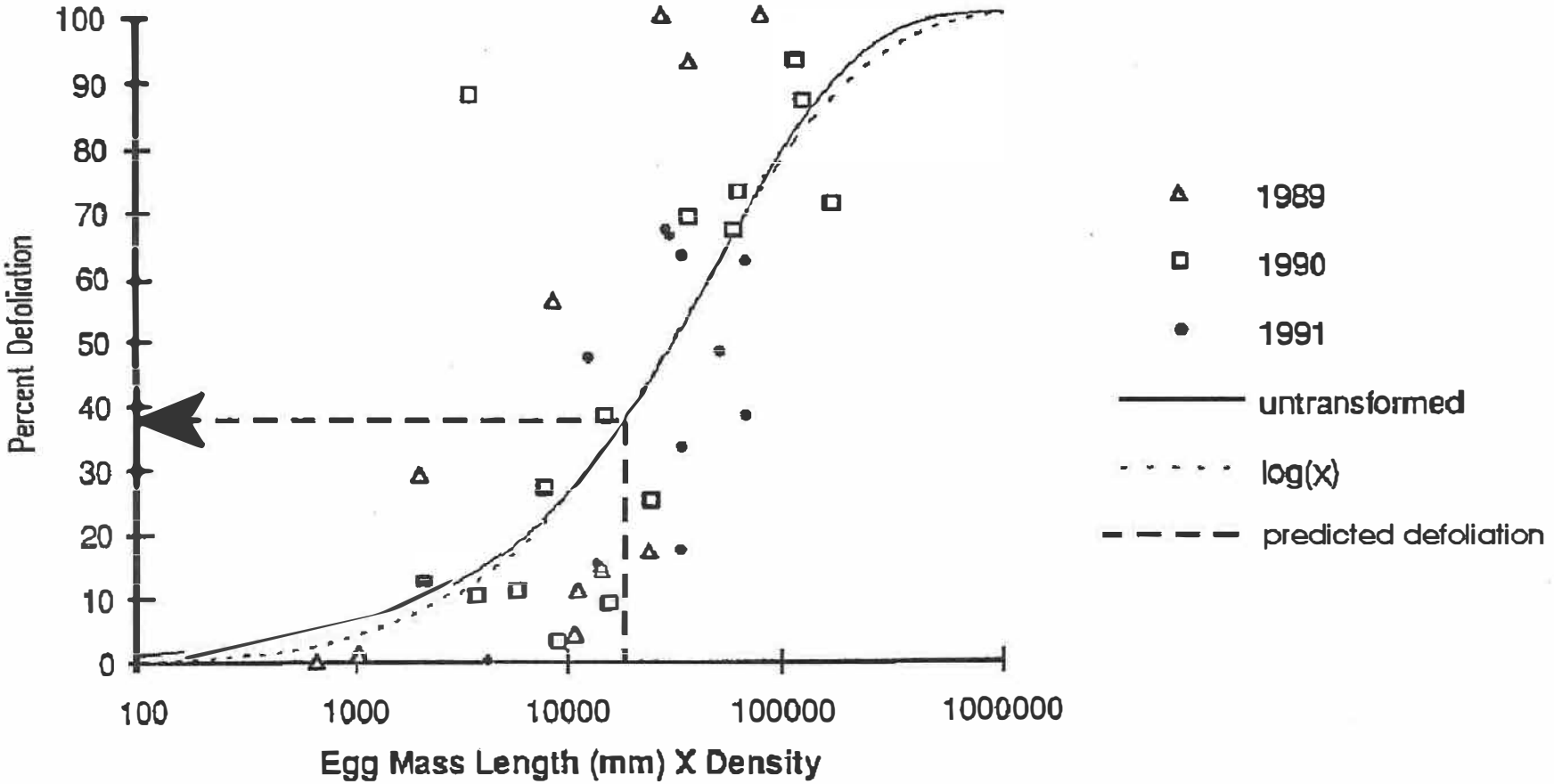
Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed at CMP. The average egg mass length is 29 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at CMP in 2000. Although it is still possible that either the gypsy moth fungus or the NPV could cause the general collapse of the gypsy moth population next year, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2001.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. Droughty conditions have been experienced in this portion of Maryland during the summer months in 1995, 1997, 1998 and 1999. However, adequate rainfall occurred during the growing season in 2000. Gypsy moth defoliation also occurred in 2000 at CMP. Approximately 12 acres of moderate defoliation and 12 acres of heavy defoliation were detected during the aerial survey on June 19.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent

Figure 3.--Predicted defoliation at Catoctin Mountain Park in 2001 based on egg mass length and density.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

(range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality. Based on observations of the existing health of the forested areas at CMP and the factors mentioned above, large areas of extensive tree mortality are not expected should defoliation occur in the absence of drought conditions in 2001. Mortality is expected to be highest in areas that were defoliated in both 2000 and 2001 and will be much more prevalent if adequate rainfall in not received during the 2001 growing season.

Management Options

For 2001, two management options have been evaluated for managing gypsy moth populations at CMP. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga.* In areas with defoliating level of gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with the information at hand, it is unlikely that a collapse will occur in 2001 since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that moderate defoliation will occur in the eastern portion of CMP in 2001.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely. Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, 3-5 days apart. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2001 should this insecticide be preferred for use at CMP.

Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1. -No action

Alternative 2. -One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3 -Two aerial application of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4 -Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations in the eastern portion of CMP are healthy, building and sufficient to cause moderate defoliation in 2001. In order to protect tree foliage and prevent subsequent tree mortality, our recommendation is for either Alternative 2 (a single application of *Btk*) or alternative 4 (double application of Gypchek). Unless there is sufficient cause for concern regarding potential impacts of *Btk* to non-target lepidopterous larvae, a single application of *Btk* is more economical.

This recommendation is based on the following considerations.

1) The current population density does not warrant a double application of *Btk*.

2) It is likely that a single application of *Btk* will provide adequate foliage protection and sufficiently reduce gypsy moth populations.

3) A double application of Gypchek would provide adequate foliage protection and sufficient population reduction.

4) The cost of a single application of *Btk* is about one half that of a double application of Gypchek.

REFERENCES

Allegheny National Forest, Warren, PA. 1988. Gypsy moth caused oak mortality – Allegheny National Forest, 1988. USDA Forest Service internal report prepared by Forest Pest Management staff, Morgantown, WV. Unp.

Gottschalk, K.W. 1990. Gypsy moth impacts on mast production, *In:* McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 42-50.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. American Entomologist 36:2, 135-139.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera:Lymnatriidae). Environ. Entomol. 16: 165-167

Sample, B.E., Butler, L., Zivkovich, C., Whitmore, R.C., and Reardon, R.C. 1996. Effects of *Bacillus thuringiensis* Berliner var. *Kurstaki* and defoliation by gypsy moth [*Lymantria dispar* (L.) (Lepidoptera:Lymnatriidae)] on native arthropods in West Virginia. The Canadian Entomologist 128:573-592.

West Virginia Division of Forestry. 1997. *In* 1997 Cooperative State-County-Landowner Gypsy Moth Suppression Program in West Virginia. 3p. (Brochure).

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File Code: 3420
Date: January 2, 2001

Mr. Mel Poole
USDI National Park Service
Catoctin Mountain Park
Thurmont, MD 21788

Dear Mr. Poole:

Enclosed is the gypsy moth biological evaluation for Catoctin Mountain Park.

In brief, gypsy moth populations are sufficient to cause moderate defoliation in the eastern portion of the Park. We are recommending a single application of *Bacillus thuringienis* variety *kurstaki (Btk)* or a double application of Gypchek on 839 acres. With proper application, gypsy moth defoliation should be minimal at Catoctin Mountain Park in 2001.

Thanks again to your staff for conducting the preliminary egg mass survey.

Please contact Rod or Brad at (304) 285-1541 if you have any questions concerning the gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

Cc: James Voight, CMP
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Robert Tichenor, MDA
Betsie Handley, MDA
Harvey Schultz, Navy
Noel Schneeberger, AO

JWH/blm